Eur J Vasc Endovasc Surg 33, 272–276 (2007)
doi:10.1016/j.ejvs.2006.09.006, available online at http://www.sciencedirect.com on ScienceDirect

Glasgow Aneurysm Score Predicts the Outcome after Emergency Open Repair of Symptomatic, Unruptured Abdominal Aortic Aneurysms

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Objective. *To determine the predictor factors of in-hospital postoperative mortality in patients presenting with symptomatic but not ruptured abdominal aortic aneurysm (AAA) at our institution.*
Patients and methods. *Forty-two patients who underwent urgent open repair for symptomatic, non-ruptured AAA were evaluated retrospectively.*
Results. *Five patients (11.9%) died during the in-hospital stay. History of coronary artery disease ($p = 0.014$), cerebrovascular diseases ($p = 0.015$), renal failure according to Glasgow Aneurysm Score (GAS) criteria ($p = 0.001$), serum creatinine concentration ($p = 0.026$), and the GAS ($p = 0.008$) were predictive of postoperative death. The ROC curve analysis showed that the Glasgow Aneurysm Score had an area under the curve of 0.870 (95%C.I. 0.71–1, S.E. 0.08, $p = 0.008$), and its best cut-off value in predicting postoperative death was 90.0 (specificity 89.2%, sensitivity 80.0%). The postoperative mortality rate of patients with a Glasgow Aneurysm Score below 90 was 2.9%, whereas it was 50% for those with a score ≥ 90 ($p = 0.003$, O.R. 33.0).*
Conclusion. *This study shows that the Glasgow Aneurysm Score is a good predictor of postoperative mortality and morbidity after urgent repair of symptomatic, non-ruptured AAA and can be useful in identifying those patients whose operative risk is prohibitive. Its simplicity makes it a clinically important tool, particularly, in the emergency setting. Patients having a score less than 90 can safely undergo urgent open repair. Thorough evaluation and improvement of preoperative status followed preferably by an endovascular repair is indicated for those with a score ≥ 90.*

Keywords: Symptomatic aneurysm; Unruptured abdominal aortic aneurysm; Glasgow aneurysm score; Emergency.

Introduction

A large number of studies have been carried out to assess the preoperative risk factors affecting the outcome after elective or emergency open surgical repair of abdominal aortic aneurysms (AAA). However, the determinants of outcome following repair of symptomatic non-ruptured AAA are less clear. These patients present with abdominal or back pain, or tenderness on aneurysm palpation, which suggest an acutely expanding AAA and a risk of imminent rupture. Although evaluation of the preoperative status may not be adequate, it is widely accepted that urgent repair is needed to prevent blood loss from aneurysm rupture in order to avoid increased mortality and morbidity caused by an eventual haemodynamic instability.[1]

This retrospective study aims to determine the predictor factors of in-hospital postoperative mortality in patients presenting with a symptomatic, non-ruptured AAA at our institution.

Patients and Methods

Forty-six urgent open repairs for symptomatic, non-ruptured AAA have been performed from September 1988 to July 2005 at the Department of Vascular Surgery of Padua University Hospital. Four patients were not included into the retrospective analysis because few data were available (sex, age and preoperative haemoglobin) and it was not possible to calculate the Glasgow Aneurysm Score. These patients, aged from 69 to 74 yrs, were discharged from hospital 2 weeks after surgery with a complete recovery. The

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1078–5884/000272 + 05 $32.00/0

diagnosis of AAA was made by ultrasound or CT-scanning. In no case did ultrasound and CT scans demonstrate any signs of retroperitoneal or peritoneal haematoma. The main indication to perform an emergency open repair was the presentation of continuous and prolonged abdominal and/or back pain. During the intervention there were no signs of AAA rupture.

Patients' data regarding previous cardiovascular, respiratory, renal, neurologic and gastrointestinal diseases as well as at the time of presentation were retrospectively collected. The Glasgow Aneurysm Score was calculated in order to evaluate the preoperative risk according to the following formula: risk score = (age in years) + (7 points for myocardial disease) + (10 points for cerebrovascular disease) + (14 points for renal disease).[2,3] Myocardial disease refers to previously documented myocardial infarctions, or coronary artery disease, or on-going angina pectoris. Cerebrovascular disease refers to all grades of strokes including transient ischemic attacks. Renal disease refers to history of chronic or acute renal failure, and/or creatinine >150 μmol/L and/or urea >20 mmol/L at admission.

Regarding data collection on the postoperative status of the patients, a renal complication was considered as a relevant increase in serum creatinine concentration requiring medical treatment or dialysis. Respiratory complications were regarded as pulmonary murmurs on auscultation, as well as findings of atelectasia or pleural effusion on chest X-rays as well as pneumonia. Diagnosis of myocardial infarction was made in the presence of characteristic changes on electrocardiogram and when serum troponin concentrations was >0.15 μg/L or serum CK-MB >5 μg/L. Postoperative mortality refers to 30-day or in hospital mortality.

During the study period changes in perioperative management of AAA may have influenced patient outcome. Changes in anaesthetic agents occurred, such as the use of new halogenated drugs (sevolfurane or isoflurane) that maintained a higher glomerular filtration rate, renal blood flow and urine flow during elective AAA repair[4] and vecuronium that has advantages over other muscle relaxants in terms of cardiovascular stability.[5] Furthermore use of β-blockers and fenoldopam, a highly selective D_1 agonist, have likely helped to reduce perioperative morbidity, due to the reduction of myocardial ischaemia[6,7] and increase in creatinine clearance associated with aortic clamping[8,9] respectively.

Statistical analysis

Statistical analysis was performed with a SPSS statistical program (SPSS v. 10.0.5, SPSS Inc., Chicago, Ill., USA). The Fisher's exact test was used for univariate analysis and the Mann-Whitney test to assess the distribution of continuous variables according to outcome end-points. Logistic regression with the help of backward selection was used for multivariate analysis. Only those variables with $p < 0.05$ at univariate analysis were included into the regression model. The accuracy of the Glasgow Aneurysm Score in predicting postoperative mortality and the identification of its best predictive cut-off value were evaluated by the receiver operating characteristic (ROC) curve. Statistical significance was considered when $p < 0.05$.

Results

The preoperative clinical variables of these patients are presented in Table 1. The postoperative complications are listed in Table 2. Pulmonary disease was the most common postoperative complication (17 patients; 40.5%); 10 patients (23.8%) developed respiratory insufficiency that required prolonged ventilatory assistance. Five patients (11.9%) died during the in-hospital stay from cardiac complications; 3 (7.1%) from myocardial infarction, 1 (2.4%) from congestive heart failure and 1 (2.4%) from arrhythmia. In 11 patients (23.9%) pain persisted after surgery.

The mean hospital stay in these series of patients was 12.3 ± 14.7; they were all discharge in good conditions with the exception of the patient that suffered a postoperative stroke. In two patients a postoperative

Table 1. Characteristics of study population

	No. (%)
Number of patients	42
Age	71.17 (68.2–74.1)
Females	3 (7.1)
Aneurysm diameter (mm)	62.6 (55.6–69.9)
Chronic obstructive pulmonary disease	8 (19.0)
Lower limb ischemia	3 (7.1)
Transient ischemic attack	4 (9.5)
Stroke	2 (4.8)
Cerebrovascular disease according to the Glasgow Aneurysm Score criteria	6 (14.3)
Myocardial infarction	12 (28.6)
On going angina pectoris	1 (2.3)
Coronary artery disease according to the Glasgow Aneurysm Score criteria	19 (45.2)
Heart failure	1 (2.4)
Arrhythmia	9 (21.4)
Hypertension	35 (83.3)
Diabetes	6 (14.3)
Preoperative creatinine	120.9 (96.4–195.4)
Renal failure according to the Glasgow Aneurysm Score criteria	7 (16.7)
Glasgow Aneurysm Score	77.6 (73.3–82.0)

Continuous variables are reported as median with interquartile ranges.

Table 2. Postoperative complications

Postoperative complications	No. (%)
Respiratory complications	17 (40.5)*
Renal complications	11 (26.2)§
Myocardial infarction	10 (23.8)#
Arrhythmias	9 (21.4)
Pancreatitis	5 (11.9)
Wound complications	4 (9.6)
Lower limb ischemia	3 (7.1)
Intestinal occlusion	3 (7.1)
TIA	2 (4.8)
Sepsis	2 (4.8)
Intestinal ischemia	2 (4.8)
Heart failure	1 (2.4)
Stroke	1 (2.4)
Lower limb vein thrombosis	1 (2.4)
Multiorgan failure	1 (2.4)
Renal encephalopathy	1 (2.4)

* 10 pts (23.8%) required a prolonged ventilatory assistance, 7 (16.7%) had pneumonia.
§ 2 pts (4.8%) required a temporary heamodialysis.
# No one required a coronary angioplasty or stent.

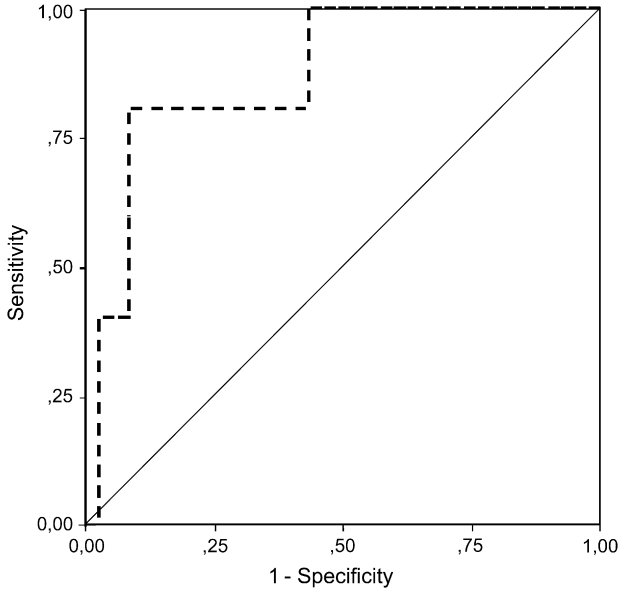

Fig. 1. Roc curve analysis shows that the GAS had an area under the curve of 0.87 (95% C.I.: 0.7−1, S.E.: 0.07, $p = 0.005$).

TIA occurred and imaging demonstrated the patency of the carotid arteries and no lesion of the cerebral parenchyma. They were discharged 12 and 14 days after surgery without any neurological sequel.

The univariate statistical analysis showed that coronary artery disease ($p = 0.014$), cerebrovascular diseases ($p = 0.015$), renal failure according to the Glasgow Aneurysm Score criteria ($p = 0.001$), preoperative serum creatinine concentration ($p = 0.026$), and the Glasgow Aneurysm Score ($p = 0.008$) were associated with increased risk of postoperative mortality. The median Glasgow Aneurysm Score of patients who died postoperatively was 96.6 (IQR: 84.4−105.1), whereas it was 75.1 (IQR: 67.3−82.3) among survivors (Table 3). Multivariate analysis failed to identify any independent predictor of postoperative mortality, likely because of the small size of this series.

The ROC curve analysis (Fig. 1) showed that the Glasgow Aneurysm Score had an area under the curve of 0.870 (95% C.I. 0.7−1, S.E. 0.07, $p = 0.005$), and that its best cut-off value to predict postoperative death was 90 (specificity 89.2%, sensitivity 80.0%). The postoperative mortality rate of patients with a Glasgow Aneurysm Score below 90 was 2.9% (one out of thirty-seven patients), whereas it was 50% for those with a score over 90 (four out of eight patients) ($p = 0.003$, O.R. 33.0; 95% C.I. 2.921−372.818). Despite improvements in peri-operative management of AAA during the study period, no relationship between the risk of death and the year patients were treated was demonstrated. This finding could be related to the small size of the study.

Table 3. Results of univariate analysis

	Alive (37 pts) No. (%)	Death (5 pts) No. (%)	*p*
Age	70.9 (69−79)	71 (65−78)	n.s.
Aneurysm diameter	62.21 (49.1−70.1)	66.6 (65.2−69.2)	n.s.
Chronic obstructive pulmonary disease	6 (16.2)	2 (40)	n.s.
Lower limb ischemia	3 (8.1%)	0	n.s.
Cerebrovascular disease according to the Glasgow Aneurysm Score criteria	3 (8.1)	3 (60)	0.015
Coronary artery disease according to the Glasgow Aneurysm Score criteria	14 (37.8)	5 (100)	0.014
Arrhythmia	8 (21.6)	1 (20)	n.s.
Diabetes	5 (13.5)	1 (20)	n.s.
Preoperative creatinine	103.1 (81.1−101)	252.3 (177.2−345.1)	0.026
Renal failure according to the Glasgow Aneurysm Score criteria	3	4	0.001
Glasgow Aneurysm Score	75.1 (67.3−82.3)	96.6 (84.4−105.1)	0.008

Continuous variables are reported as median with interquartile ranges.
n.s.: not significant.

The Glasgow Aneurysm Score ($p = 0.008$), preoperative coronary artery disease ($p = 0.03$), and preoperative renal failure according to the GAS criteria ($p < 0.0001$) were also significantly associated with an increased risk to develop postoperative renal failure.

Discussion

Abdominal aortic surgery is a major surgical procedure and its outcome depends on the situation under which it is performed. Indeed, some centers have reported an in-hospital postoperative mortality rate after elective operations ranging from 2.8% to 8.2%,[10–13] whereas symptomatic, non-ruptured AAA repaired in an emergency setting is associated with a mortality ranging from 11% to 18%.[1,14,15] These results may be explained by the fact that the latter group of patients may present with greater co-morbidity as well as inadequate preoperative evaluation, compared to patients undergoing elective surgery.[1,11,15]

The Glasgow Aneurysm Score is a simple method to stratify preoperative risk and has been proven to be accurate in predicting the postoperative outcome after elective open repair of AAA.[13] The evaluation of our series shows that the Glasgow Aneurysm Score is a good predictor of postoperative mortality and morbidity after emergency repair of symptomatic, non-ruptured AAA, and can be valuable to identify those patients whose operative risk is prohibitive. Its simple application enhances its clinical importance in the emergency setting.

We have identified a value of 90 as a cutoff below which emergency open repair was associated with a fairly low postoperative mortality rate. In contrast, the remaining patients with symptomatic, non-ruptured AAA who had a Glasgow Aneurysm Score $\geq$90, had a 33-fold increased risk of postoperative death compared to the patients with a score below 90 (50% vs. 2.9%, $p = 0.003$). Such a poor outcome is similar to that after emergency repair of ruptured AAA.[16] The result of our study are similar to those obtained in a study by Leo *et al*. in which in a series of 42 patients that underwent urgent repair for symptomatic AAA, it was shown that good postoperative survival rate can be expected in patients with a Glasgow Aneurysm Score <85 (specificity 86.8%, sensitivity 75.0%).[17]

Some authors discourage an immediate aneurysm repair in all cases of symptomatic, non-ruptured AAA which, has been reported to lead to worse postoperative results than delayed repair.[1,14,18] The optimal management of this type of patients is not yet well defined.[14] Bearing in mind the result of the present research, we recommend that in those patients with a symptomatic, non-ruptured AAA who have a Glasgow Aneurysm Score over 90 a thorough evaluation regarding their cardiac, renal, and pulmonary status should be made. We believe that in these patients an accurate preoperative evaluation must be done to treat specific concomitant pathology not only periopertively (as for the use of fenoldopam in case of renal insufficiency, or β-blocker in case of coronary artery disease), but also in the intensive care unit post-operatively.

Concerning the operative technique that should be adopted for a high-risk patient with an acute symptomatic, non-ruptured AAA we believe that when the endovascular treatment is feasible, it represents a better choice than open repair because of possible poor results of the latter treatment method. Recent studies suggest that urgent endovascular repair is feasible in patients with symptomatic, non-ruptured AAA when the infrarenal aortic neck is suitable.[19] An important requirement is availability of the correct devices in stock.[20]

In conclusion, the Glasgow Aneurysm Score is accurate in evaluating the preoperative conditions and in predicting the outcome after surgical repair of patients presenting with a symptomatic, non-ruptured AAA. Patients whose GAS is lower than 90 can safely undergo urgent open repair. Thorough evaluation and improvement of preoperative status followed preferably by an endovascular repair is indicated for those with a score $\geq$90.

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Accepted 7 September 2006
Available online 9 November 2006